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(54) **Injection moulding process for soles in expandable and cross-linking "EVA" based compounds**

(57) This invention concerns an injection moulding process for soles in expandable and cross-linking "EVA" based compounds characterised in that during the cooling stage of the moulded sole (1) the spontaneous shrinkage of the same is arrested by means of a tem-

plate (3) placed on the sole (1) so that the series of perimeter pin elements (3a) on the bottom surface of the template (3) couple with a corresponding series of perimeter holes (2) on the upper surface of the sole (1) whose dimensions reduce no further either during the remaining cooling phase or after cooling.

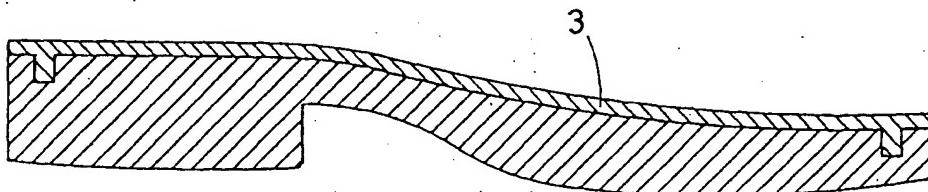


FIG. 4

## Description

This patent application concerns an injection moulding process for soles in expandable and cross-linking "EVA" based compounds.

The patent protection is also extended to the sole obtained with the process according to the invention.

The abbreviation "EVA" refers to "vinyl-acetate ethylene copolymer" which, according to the type of additive used, may be thermoplastic or expandable and cross-linking.

In the case of the latter type, an expanding powder additive is used which decomposes at a specific temperature to produce gases which give rise to a typical phenomenon which occurs in injection moulding using this type of "EVA", consisting of the instantaneous expansion of the part as soon as the mould is opened.

In particular the dimensions of the part increase rapidly while the proportions and shape remain unaltered thus maintaining a ratio of perfect similarity with the impression of the matrix.

Expandable and cross-linking "EVA", thanks above all to its low cost, is widely used in the footwear sector for the production of inexpensive injection moulded soles.

It is not however currently possible with this material to mould soles with a raised trim along the sides since the expansion of the part when the mould is opened requires the perimeter of the sole to be milled in order to reduce the sole to the necessary dimensions.

In other words, since it is not possible to control this expansion precisely, it is currently necessary to dimension - according to the expansion ratio of the material and that of its shrinkage during cooling - the impression of the mould so that the cooled moulded sole is slightly oversized with respect to the nominal dimensions of the sole sizes in question, which are obtained by milling away a surface layer of material along the entire perimeter of the sole.

It is thus obvious why this material and moulding system can not be used for soles which have a raised trim, such as a welt, a part or all of which would be removed when the sides of the sole are milled.

The purpose of this invention is to design an injection moulding process for soles made of expandable and cross-linking "EVA" that makes it possible to produce a perfectly sized sole and to eliminate the costs and limitations of the milling which is currently necessary to size soles made of expandable and cross-linking "EVA" compounds.

The process according to the invention derives from an idea for a solution which is, in general terms, exactly opposite to that on which current production techniques are based.

According to this innovative idea, based on the expansion ratio of the material and that of its shrinkage during cooling, the impression of the mould is designed so that the moulded sole is slightly undersized after cool-

ing and shrinkage with respect to the nominal dimensions of the size in question, which are however strictly respected by arresting the spontaneous shrinkage of the sole during cooling.

For this purpose, the process according to the invention involves the use of a template consisting of a thin and flexible plate from whose bottom edge project a series of perimeter pin elements to which said template may be joined integrally or coupled with the sole, which is in turn provided on its upper surface with a series of perimeter holes corresponding to the above pin elements. It follows that the coupling of the sole and template must occur before the cooling process of the sole is completed and when said series of holes, drawn together by the gradual shrinkage of the sole during cooling, are positioned exactly over the template pin elements, which after housing into the respective holes, prevent any further shrinkage of the sole, whose dimensions reduce no further either during or after cooling.

For major clarity the description of the process according to the invention continues with reference to the enclosed drawings which are intended for purposes of illustration and not in a limiting sense and which schematically show the moulded sole before and after shrinkage following cooling, whereby:

- fig. 1 is a cross-section along a longitudinal plane of the sole injected with expandable and cross-linking "EVA" compounds immediately off the mould in maximum expansion dimensions;
- fig. 2 is a view from the bottom of the above template designed to arrest the shrinkage of the sole during the post-moulding stage;
- fig. 3 is a cross-section of the sole in fig. 2 along a longitudinal plane III-III;
- fig. 4 is a view of the template positioned on the sole both cross-sectioned along a longitudinal plane;
- fig. 5 is a cross-section along a longitudinal plane, of the sole produced with the moulding system according to the invention. Before describing the operating stages of the moulding process according to the invention, it is important to remember that in order to realise the process according to the invention, the impression of the sole must be designed to ensure that the sole off the mould after complete and spontaneous shrinkage is slightly undersized with respect to the nominal dimensions of the size in question.

Moreover the impression of the mould must be designed so that the sole off the mould, regardless of its shape or pattern of the treading surface and its sides, has a series of perimeter holes on its upper surface.

This being so, the actual moulding process is attained according to current technology by injecting granules of expandable and cross-linking "EVA" compound into a mould, maintained at a specific temperature to ensure that during the time the material remains in the

mould, cross-linking and decomposition of the expanding fillers, occur.

This conventional moulding phase produces a sole of the type illustrated in figure 1 which, as mentioned above, shows the sole in the maximum dimensions of expansion, that the sole attains immediately the mould is opened.

As can be seen in figure 1, sole (1) is characterised by a series of perimeter holes (2) along its upper surface (1a).

The process according to the invention provides that the sole (1) during cooling is coupled by a template (3) consisting of a thin flexible plate made of rigid material such as rigid P.V.C., having a profile similar to that of the sole (1) with a series of pin elements (3a) projecting from its bottom surface corresponding to the series of holes (2) on sole (1), and into which, before completion of the cooling process, the corresponding pin elements (3a) of the template (3) house, in this way preventing any further shrinkage of the sole, whose dimensions reduce no further either during or after cooling.

After cooling, the pin elements (3a) of the template (3) are detached from the corresponding holes (2) on the sole.

The sole (4) thus obtained, is shown in fig. 5, with the same shape but reduced dimensions with respect to the sole (1) shown in figure 1.

Finally, in order to ensure the perfect entry of the pin elements (3a) of the template (3) into the holes (2) on the sole (1), the process according to the invention provides that a slight pressure be created on the template (3), during cooling, by suitable means, the most convenient and simplest of which may consist of small weights placed on the template (3).

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- said pin elements (3a) remain in the holes (2) until the cooling process of the sole is completed;
- said pin elements (3a) of the template (3) are extracted from the holes (2) of the sole, after cooling.

2. A process according to the previous claim characterised in that the template (3) is subject to a slight pressure in order to ensure the perfect entry of the pin elements (3a) in the holes (2) on the upper surface of the sole (1).

3. An injection moulded sole made of expandable and cross-linking "EVA" compounds produced with the process according to the previous claims.

## Claims

1. An injection moulding process for soles produced with expandable and cross-linking "EVA" based compounds characterised in that - expandable and cross-linking "EVA" based compound granules are injected into a mould whose impression is on one hand sized to ensure that the sole off the mould (1) after spontaneous and complete shrinkage, is slightly undersized with respect to the nominal dimensions of the sole size in question, and on the other hand is designed so that said moulded sole has a series of perimeter holes (2) on its upper surface;

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- a template (3), consisting of a thin flexible plate made of rigid material having a profile similar to that of the sole (1) provided on its bottom surface with a series of pin elements (3a) designed to fit into the corresponding series of holes (2) of the sole (1), is coupled on the upper surface of the sole (1) during cooling;

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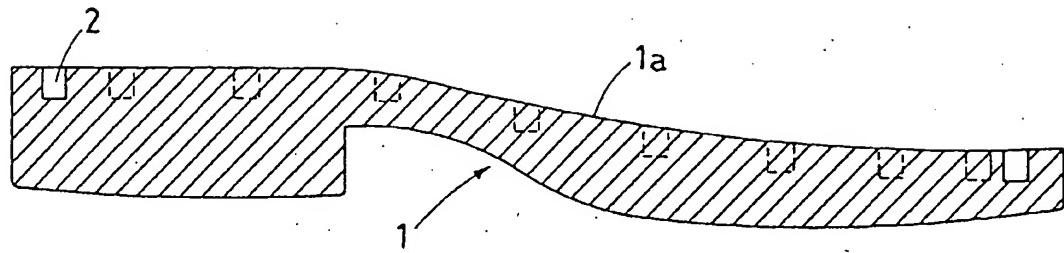


FIG. 1

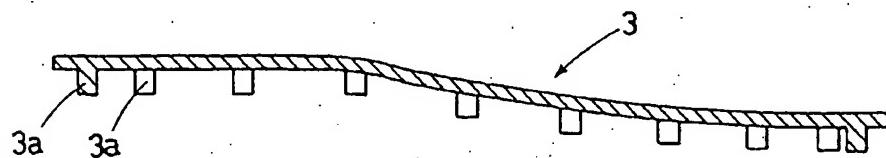


FIG. 3

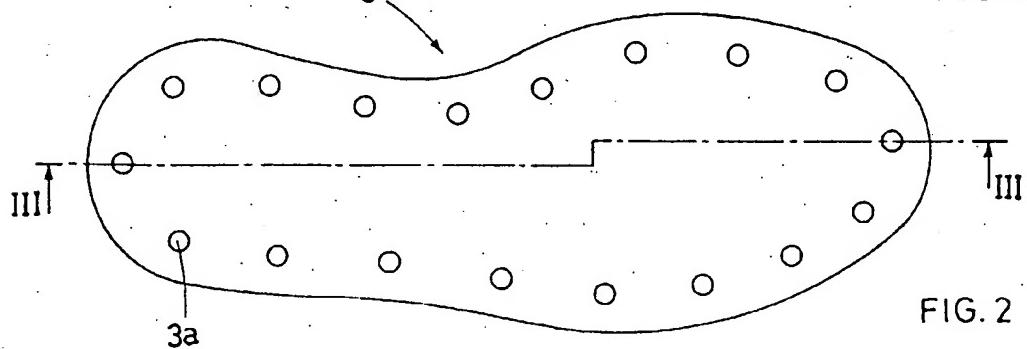


FIG. 2

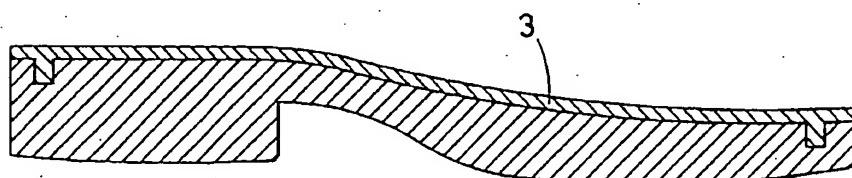


FIG. 4

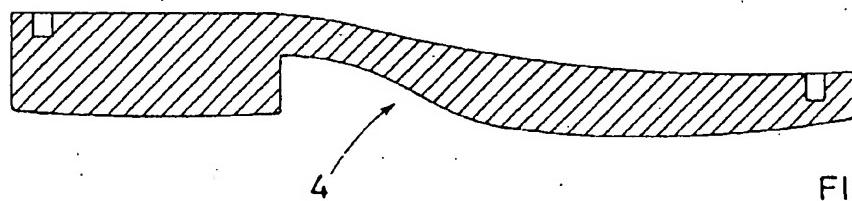


FIG. 5